

# Evaluation of logistics performance of Y garment enterprises in the context of “double carbon policy”

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**Abstract:** Under the call of the national "double carbon policy" and the awareness of energy saving and emission reduction, some traditional industries are gradually eliminated, and the garment industry, in response to the policy of low carbon and environmental protection, is gradually changing to the direction of green, environmental protection and low carbon, actively restructuring its enterprises, creating a low carbon, diversified modern enterprise system, and achieving low carbon transformation and coordinated with high-quality economic development. Based on the background of the dual carbon policy, this paper establishes a logistics performance evaluation index system for Y garment enterprise, and combines the combined model of AHP-DEA for specific analysis. It is found that Y garment enterprise has the problems of insufficient production scale, low input efficiency and low resource utilisation, which are not conducive to the low carbon and green development of the enterprise. According to the research findings, corresponding suggestions and countermeasures are proposed to actively introduce high-tech equipment, improve the efficiency of enterprise logistics and distribution and improve the quality of enterprise logistics services.

**Keywords:** double carbon; apparel companies; logistics performance evaluation; AHP-DEA

## 1. Introduction

In recent years, China has proposed a "double carbon policy" to create a green economy, specifically expressed as a two-stage carbon reduction target, i.e. peak carbon by 2030 and carbon neutral by 2060. The "dual carbon policy" will lead to many new industries, such as carbon finance, management of carbon emission rights, etc. The "double carbon policy" will lead to the development of many new industries, such as carbon finance, management of carbon emission rights, etc. The traditional garment industry will eventually face elimination if it fails to transform its development structure and low-carbon production. Therefore, the dual carbon policy process will promote the garment industry to actively transform the enterprise structure, forming a lower input, higher output of green low-carbon environmental protection enterprise system.

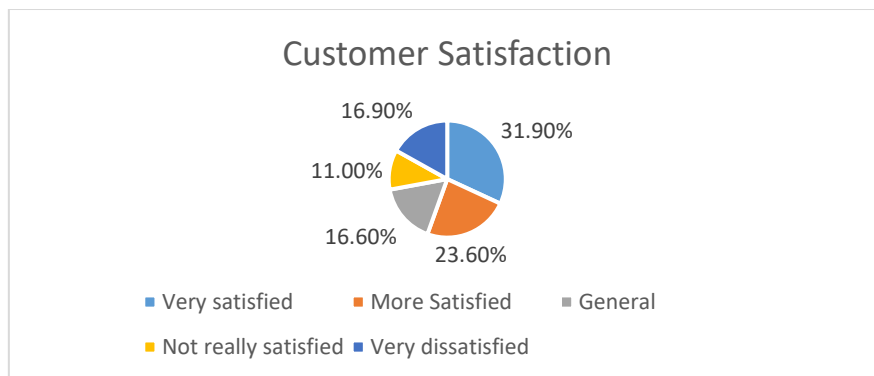


Figure 1: Customer satisfaction survey form for Y garment company

Since the reform and opening up, Ningbo, as a city with a long history of garments, has seen rapid development of the garment industry and a rapid increase in foreign exports of garments, with achievements ranking among the top of major cities in China. The development of Ningbo garment enterprises has always had a deep history of accumulation, has formed a complete range of categories, enterprise chain complete enterprise system, the total industrial output value has exceeded one hundred

billion yuan, statistics show that as of the first half of 2021, Ningbo textile and garment enterprises completed a total industrial output value of 56.47 billion yuan, an increase of 12.8%; to achieve industrial added value of 11.68 billion yuan, up 10.9%. In July 2021, the "Fourteenth Five-Year Plan" for the development of the textile industry was released, and it was clearly pointed out that the "Fourteenth Five-Year Plan" development goals required a new level of green development. "At the end of the 14th Five-Year Plan, the energy structure of the textile and garment industry will be further optimised, the efficiency of energy and water use will be further improved, energy consumption and carbon dioxide emissions per unit of industrial added value will be reduced by 13.5% and 18% respectively, and the pressure on textile enterprises to transform and upgrade will be urgent. Accelerate the transformation and develop new production technologies.

As of the first quarter of 2022, the net profit of Y Garment Enterprise in Ningbo was RMB 2.118 billion, a decrease of 71% year-on-year. The customer satisfaction survey was conducted by sending feedback emails to customers of Y garment enterprises, as shown in Figure 1. In order to respond to the implementation of the "double carbon policy", Y garment enterprise in Ningbo has to actively change its development mode, improve its logistics performance and transform from a traditional labour-intensive enterprise to a technology-intensive enterprise in the face of low logistics efficiency, low resource utilisation and high costs. Therefore, this paper adopts a combined AHP-DEA research method to evaluate and analyse the logistics performance of Y garment enterprises in the context of the "double carbon policy", using Y garment enterprises in Ningbo as the research object. Firstly, based on the research results of scholars at home and abroad, the AHP research method is used to establish the evaluation system of the relevant indicators of the logistics performance of the garment enterprises, and the weights of the indicators in the indicator system are calculated through expert scoring and MATLAB software.

## 2. Review of the literature

Enterprise logistics performance evaluation refers to the use of specific enterprise logistics performance evaluation indicators, unified logistics evaluation standards, the corresponding evaluation models and evaluation calculation methods, in order to achieve the purpose of reducing enterprise logistics costs, to be able to make an objective, fair and accurate assessment of the enterprise's input and output (output and benefit) of the logistics system, which is a good reference for the future development of enterprises. Experts and scholars at home and abroad are increasingly interested in the study of logistics performance, and their research perspectives and methods are different, and most of them are still focused on quantitative research.

(I) In terms of the selection of indicators for logistics performance, Kumar et al. (2010) consider the level of infrastructure development as one of the important indicators for evaluating the logistics performance of import and export trade in Central Asia. Yan Berry<sup>[1]</sup> (2021) conducted an in-depth study on logistics performance among countries, mainly focusing on logistics performance in the six aspects of logistics cost, quality of transport-related infrastructure, logistics efficiency, quality and capacity of logistics services, ability to track goods, and timeliness of shipments to do a comparative analysis, and the study showed that logistics infrastructure, logistics transport and quality and capacity of logistics services can have an impact. Tao Zhang<sup>[2]</sup> (2020) found that four indicators of logistics performance, namely timeliness of shipment, ability to track and query goods, quality of transport infrastructure and transport flexibility, are important factors affecting the level of logistics performance, with the ability and quality of logistics services being the core influencing factors. Li Yonghui<sup>[3]</sup> (2020), in determining logistics performance evaluation indicators, separates the efficiency part of the indicators from the performance and uses monetary measures for economic indicators. Guo Daning<sup>[4]</sup> (2006) proposes that the evaluation of logistics performance can be analyzed from the aspects of enterprise management efficiency, enterprise competitiveness and enterprise performance as evaluation indicators by establishing a structural equation model for logistics performance measurement. Dai Kun<sup>[5]</sup> (2008) believes that the combination between logistics operation and the overall strategy of the organisation and logistics strategy, including the partnership with suppliers, integrated performance management and organisational structure, should be considered comprehensively, which can evaluate the level of logistics performance more comprehensively and help to improve the level of enterprise logistics performance. Liu Zhong<sup>[6]</sup> (2021) established an evaluation system on logistics performance of ports, mainly based on the scale of port construction, infrastructure indicators, logistics scale and socio-economic development level, etc. for evaluation and analysis.

(II) In terms of research methods for logistics performance evaluation indicators, Wang

Dongsheng<sup>[7]</sup> (2020) uses Likert's five-level scale method to explore the feedback on logistics performance through questionnaire scoring, while also ensuring the authenticity and scientificity of the data. The components of logistics development are compared through radar chart analysis to improve the overall logistics performance level from the components of logistics performance. Li Yonghui et al.<sup>[3]</sup> (2020) combined DEA analysis, factor analysis and entropy method to analyse and explore the aspects of urban logistics efficiency, performance and competitiveness. Huang Qinghua et al.<sup>[8]</sup> (2021) used DEA to establish a logistics performance evaluation system for key provinces and cities in China's "Belt and Road" construction, and compared the logistics performance levels among key provinces and cities in China with reference to 14 logistics performance-related indicators, including regional economy, logistics policy and digital logistics.

The above research is summarised, although there have been many studies on logistics performance by scholars at home and abroad, there are still not many relevant studies specifically on the logistics performance of apparel enterprises, and DEA is a typical multi-objective efficiency evaluation method. Therefore, based on the findings of scholars at home and abroad, this paper uses a combined model of AHP and DEA to study the logistics performance of Y garment enterprises in Ningbo, establishes a corresponding evaluation system, identifies the problems and puts forward corresponding improvement suggestions based on the research results.

### **3. Research methodology and content**

#### **3.1 Hierarchical analysis**

In the 1870s, the American operations researcher Satie first proposed AHP analysis (hierarchical analysis), the essence of which is to stratify decision-making by weights and to establish a system of evaluation indicators that fit into the objective, normative and programme layers, and finally to compare expert ratings with the assessment results to produce a judgement matrix that fits. A mathematical model is then established, and the judgement matrix is then mathematically analysed to derive the weights of each indicator. The use of the hierarchical grading method simplifies the handling of complex problems.

#### **3.2 Data Envelopment Analysis**

DEA analysis (Data Envelopment Analysis) was first proposed in the 1870s by the famous operations researcher Cooper, Rhodes. DEA is a non-parametric statistical method based on correlation efficiency, which is mainly used to evaluate the same decision unit with the same type, different inputs and different outputs. The decision units are determined by analysing the inputs and outputs of each decision unit. Input data refers to the human and financial input, technology, etc. that the decision maker needs to put in to carry out a certain activity. Production data refers to the benefits generated by the company in the production process, such as product output, profit, customer satisfaction, etc. With the input and output data, the decision-making unit is evaluated, i.e. the relative effectiveness of the department's questioning, thus providing a clear basis for managers to improve their decision-making.

#### **3.3 Selection of logistics performance evaluation indicators**

The premise that performance evaluation can be carried out effectively is to ensure that the evaluation system is systematic and comprehensive, that the logistics operations, development status and operations of apparel enterprises are summarised systematically, comprehensively and objectively, and that a logistics performance evaluation indicator system is constructed reasonably for the specific circumstances of the enterprise. Therefore, the following guidelines should be observed when selecting indicators.

(1) Scientific validity: the evaluation indicators chosen should be scientific and the evaluation indicators should be relevant. In this paper, with the reference of Yan Berry, Tao Zhang, Li Yonghui, Guo Daning and Dai Kun, the logistics performance evaluation index was developed with reference to the World Bank's 2007 Logistics Performance Index (LPI) and the characteristics of China's garment industry.

(2) Comparability: The chosen index should be universal and comparable, therefore, the selection of indicators should take full account of the universality of the apparel industry.

(3) Accessibility: the information of the selected indicator should be available, if the information of the selected indicator is not reasonably accessible, the indicator will lose its proper value. The data selected in this paper are all from the operating statements of Enterprise Y.

Table 1: Logistics performance evaluation indicators for Y garment enterprises

Tier 1 indicators	Secondary indicators	Explanation of indicators
Corporate Inventory Management	Storage costs	The cost of warehousing a business, which includes various costs such as space, equipment and personnel.
	Resource depletion rate	That is, the degree of breakage of goods in the process of warehousing in and out of the logistics enterprise.
	Order out rate	It refers to the efficiency of the picking of goods out of the garment company after an order has been accepted and the efficiency of the garment company's warehousing operations in the face of the order (the specific value can be expressed as the ratio of on-time warehousing to total orders shipped).
	Return rate	Goods to be returned for quality inspection, no product quality problems and then repackaged for return use, can improve the order out rate and reduce inventory.
	Timeliness of delivery	That is, the time and efficiency of distribution, which can reflect the logistics efficiency of a company.
Logistics and distribution efficiency	Degree of security of distribution	This can be expressed as the ratio of accidents to total shipments during the distribution of goods, including accidents with transport vehicles, lost items, delays and other types of situations.
	Cargo loading rate	The actual loading rate of the vehicles transporting goods can reflect the efficiency of distribution to a certain extent, and a high loading rate of goods can reduce the carbon emissions of enterprises, the specific value can be expressed as the ratio of the actual number of goods loaded to the maximum loading capacity of transport vehicles.
	Packaging Reuse	That is, whether the company is able to recycle its product packaging, expressed as $(1 - \text{number of new packages} / \text{total packages})$ .
Customer Satisfaction	Timely delivery rate	That is, the number of cycles in which shipments can be made after a customer has placed an order is one of the indicators that affects the level of customer satisfaction.
	Degree of market response	This means that the company is sensitive to market demand and responds in a timely manner.
	Green packaging usage	That is, whether the company uses biodegradable plastics and foams for the packaging of its products.
Degree of informationization of enterprises	Information sharing rate	It is the extent to which information is shared between departments within the company and between employees within the business.
	Information coverage	It is an important indicator of the extent to which a company is informed in a given region.
	Information accuracy	It can reflect the effectiveness of the enterprise information technology, only accurate information can play the value of information, to a certain extent, determine the development of the enterprise.
Business operating capabilities	Environmental protection investment rate	This is the ratio of investment by companies in green facilities, such as low carbon equipment and waste water and gas treatment facilities.
	Net profit growth	Reflects the ability to continue to make a profit in the course of business.
	Current ratio of assets	Reflects the solvency of the business over a period of time.
	Total Return on Assets	That is, the ratio of inputs to outputs of a business.

In summary, this paper considers the "double carbon policy" background warehouse as a garment enterprise infrastructure<sup>[1]</sup>, so there will be high requirements for inventory management, taking into account the impact of inventory costs, resource consumption and order delivery rate; secondly, in order to respond to the "double carbon policy", logistics and transportation should not only take into account the efficiency of logistics and distribution, but also the rate of return usage; in order to ensure customer satisfaction, attention should be paid to the timely rate of logistics and the rate of green packaging usage; for the integrated management of enterprise logistics performance<sup>[5]</sup>, the degree of enterprise information technology should be expanded; finally, understanding the degree of economic development of Y garment enterprises<sup>[6]</sup> is also one of the important aspects in evaluating the logistics performance of enterprises. One of the important aspects of In this paper, the five aspects of logistics

performance, namely enterprise inventory management, logistics and distribution efficiency, customer satisfaction, the degree of enterprise informatization and enterprise operation capability, are discussed for apparel enterprises as the first level evaluation indexes, and on this basis, the second type of indexes are extended and a corresponding evaluation index system is established.

(1) Enterprise inventory management: belongs to the core competencies necessary for the logistics performance of apparel enterprises. Efficient logistics management of apparel enterprises is closely related to high-quality inventory management, so the enterprise's inventory management capability is one of the important influencing factors affecting the logistics management of apparel enterprises. This paper expands the four points of storage cost, resource depletion rate, order release rate and return rate as the secondary evaluation indicators in the evaluation system for enterprise inventory management.

(2) Logistics and distribution efficiency: As one of the important evaluation indicators in the logistics management of garment enterprises, the efficiency of logistics and distribution not only affects the operating costs of enterprises, but also has a bearing on customer satisfaction, and efficient logistics and distribution is beneficial to the stable development of enterprises. In this paper, we analyze the efficiency of logistics and distribution in terms of the timeliness of distribution, safety of distribution, loading rate of goods and reuse rate of packaging as secondary indicators.

(3) Customer satisfaction: that is, whether the customer is satisfied with the logistics services provided by the enterprise or not, to a certain extent, represents the quality of logistics services provided by the enterprise, the higher the customer satisfaction the more beneficial to the long-term development of the enterprise. For this reason, this paper takes the timely shipment rate, market response degree, green packaging utilization rate and environmental protection investment rate as the secondary evaluation indexes under the logistics service quality dimension.

(4) The degree of informationisation of an enterprise: In the era of digital economy, the level of informationisation of an enterprise has a great impact on its business performance. The higher the degree of informatization, the higher the operational efficiency of the enterprise, which is conducive to promoting the balanced development of the enterprise. For this reason, this paper takes the information sharing rate, information coverage and information accuracy rate as the secondary evaluation indicators under the dimension of enterprise informatization.

(5) Enterprise operating capability: It is an important indicator to measure the operating condition of an enterprise and one of the key indicators to assess the performance evaluation of an enterprise. For this reason, this paper expands the net profit growth rate, asset liquidity ratio and total assets return ratio as secondary evaluation indicators for enterprise economic efficiency.

#### 4. Logistics performance evaluation of Y apparel enterprises based on AHP-DEA model

##### 4.1 Data acquisition

In this paper, the answers to the questions were assessed by means of a questionnaire on a five-point scale ranging from "1" to "9", with 9 being particularly important, 7 being obviously important, 5 being relatively important, 3 being slightly important and 1 being equally important. The survey was conducted on the five aspects of inventory management, logistics and distribution efficiency, customer satisfaction, information technology and business operation capability of Y garment company. A total of 300 questionnaires were distributed and 248 valid questionnaires were finally obtained, 52 invalid questionnaires were excluded and the questionnaire efficiency rate was 82.7%.

##### 4.2 Determination of indicator weights based on the AHP method

This thesis takes Y Garment Company as the research object and establishes a logistics performance evaluation system based on Y Garment Company. Employees within the company and experts in the industry evaluate the indicators by scoring them and using MATLAB software to calculate the weights corresponding to each indicator as well as the comprehensive weights.

Table 2: Judgement matrix S

Z	S1	S2	S3	S4	S5	W	Conformity
S1	1	3	4	1/3	1/5	0.1307	Yes
S2	1/3	1	2	1/5	1/6	0.0639	Yes
S3	1/4	1/2	1	1/4	1/6	0.0478	Yes

S4	3	5	4	1	1/5	0.2247	Yes
S5	5	6	6	5	1	0.5329	Yes

(1) Using MATLAB software to perform operations, the first level indicator determination matrix S and the second indicator determination matrix C1, C2, C3, C4 and C5 were calculated, yielding the results shown in Table 2.

Its judgment matrix weights  $W = (0.1307, 0.0639, 0.0478, 0.2247, 0.5329)$  were calculated by MATLAB.  $\lambda_{\max} = 5.4137$ , and the CI value of 0.1034 and CR value of 0.0932 were obtained by substituting into the formula, and the consistency verification passed. Where  $CR < 0.1$ , this proves that the judgment matrix S is valid data that satisfies the test once. The calibration was repeated according to the above steps to check whether the other matrices satisfied the consistency.

(2) Based on the calculation of the weights of the primary indicators, the weights of the secondary indicators were determined again by the expert assessment method, as shown in Table 3.

Table 3: Table of indicator weights at each level

Tier 1 Indicator (S)	Weighting (W)	Secondary indicators (C)	Eigenvectors	Weighting values	Sorting
Enterprise inventory management capabilities	0.1307	① Storage costs	2.9907	0.5812	1
		② Resource depletion rate	0.8409	0.1634	10
		(iii) Order out rate	0.8409	0.1634	10
		④ Return rate	0.4729	0.0919	14
Logistics and distribution efficiency	0.0639	① Delivery timeliness	2.2361	0.4167	7
		② Distribution security level	2.2361	0.4167	7
		③ Cargo loading rate	0.4472	0.0833	15
		④ Packaging reuse rate	0.4472	0.0833	15
Customer Satisfaction	0.0478	① Timely shipment rate	1.4422	0.4286	5
		② The degree of market response	1.4422	0.4286	5
		③ Green packaging rate	0.4807	0.1429	12
Degree of informationization of enterprises	0.2247	① The degree of information sharing	0.6687	0.1283	13
		② Coverage of information	0.3433	0.0658	17
		(iii) Accuracy of information	2.3403	0.4489	4
		④ Investment rate in environmental protection	1.8612	0.357	9
Business operating capabilities	0.5329	① Net profit growth rate	2.0801	0.4737	2
		② Current ratio of assets	0.2311	0.0526	18
		(iii) Return on total assets	2.0801	0.4737	2

#### 4.3 Evaluation of the logistics performance of Y garment enterprises

Hierarchical analysis is limited to the analysis of indicators of influencing factors in logistics management and lacks the assessment of the performance of logistics enterprises. For this reason, this paper incorporates the DEA model. Referring to Li Congcong (2011), Lin Shan (2014) and other scholars on the AHP method for the calculation of the weight of each indicator, combined with the evaluation indicators of this paper and the actual situation of the enterprise, in order to ensure the accuracy of data analysis, this paper selected the top two weight values to obtain the input indicators including: storage costs, information accuracy; output indicators include: net profit growth rate, total assets return rate. Using DEAP2.1 software, the logistics performance of Y garment enterprise was evaluated by combining the relevant data of Y enterprise from 2012-2021, and the results are shown in Table 4.

Table 4: Table of input-output values for apparel business Y 2012-2021

Year	Storage costs (\$)	Information accuracy	Total Return on Assets	Net profit growth
2012	75246	22.00%	9.56%	-19.46%
2013	75875	28.00%	8.62%	-18.02%
2014	77217	30.00%	12.97%	136.56%
2015	76010	32.00%	11.12%	36.12%
2016	82083	38.00%	10.58%	-15.73%
2017	67675	41.00%	5.50%	-92.03%
2018	69342	66.00%	9.99%	1151.53%
2019	77657	72.00%	10.19%	7.43%
2020	74848	85.00%	14.84%	82.37%
2021	102196	92.00%	12.69%	-28.73%

#### 4.4 Analysis of DEAP results

The relevant data for Y garment enterprise for the past ten years were applied to DEAP 2.1 software to calculate the corresponding values, and the results are shown in Table 5. The BCC model (VRS) used in this paper decomposes the comprehensive benefits into technical benefits and scale benefits.

Table 5: Results of DEAP analysis for apparel company Y, 2012-2021

Year	Technical benefits	Benefits of scale	Combined benefits	Relaxation variable S-	Relaxation variable S+	Effectiveness
2012	1.000	1.000	1.000	0.000	0.000	DEA is strongly effective
2013	0.967	0.735	0.711	0.000	0.913	Non-DEA valid
2014	1.000	1.000	1.000	0.000	0.000	DEA is strongly effective
2015	0.987	0.875	0.864	0.000	0.781	Non-DEA valid
2016	0.902	0.835	0.754	0.000	1.210	Non-DEA valid
2017	1.000	0.460	0.460	0.000	1.410	Non-DEA valid
2018	1.000	1.000	1.000	0.000	0.000	DEA is strongly effective
2019	0.898	0.769	0.691	0.000	0.617	Non-DEA valid
2020	1.000	1.000	1.000	0.000	0.000	DEA is strongly effective
2021	0.718	0.916	0.658	0.000	1.169	Non-DEA valid

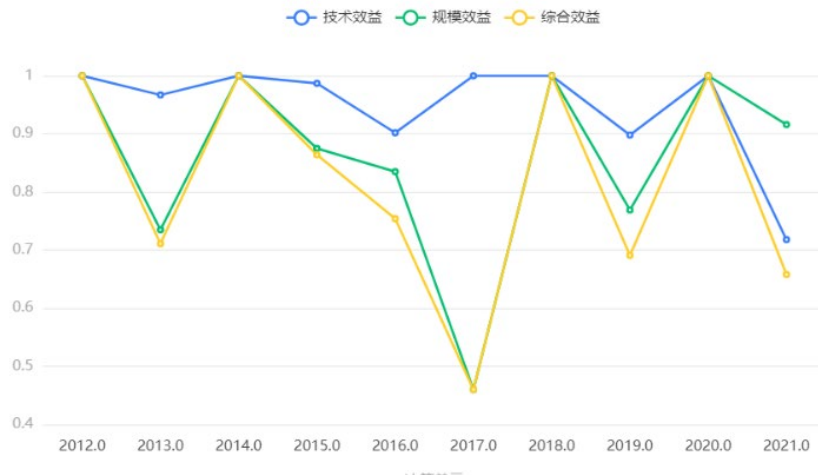


Figure 2: Effectiveness of Y apparel companies 2012-2021

The effectiveness of the efficiency of apparel company Y in 2012-2021 is shown in Figure 2. The payoffs for the size of the company were derived from the input-output data of apparel company Y in 2012-2021 and the results are shown in Table 6.

Table 6: Y Apparel Companies Size Compensation Analysis, 2012-2021

Year	Pay for scale factor	Type
2012	1.000	Fixed remuneration for size
2013	0.703	Increasing returns to scale
2014	1.000	Fixed remuneration for size
2015	0.852	Increasing returns to scale
2016	0.804	Increasing returns to scale
2017	0.407	Increasing returns to scale
2018	1.000	Fixed remuneration for size
2019	0.711	Increasing returns to scale
2020	1.000	Fixed remuneration for size
2021	0.890	Increasing returns to scale

## 5. Research conclusions and countermeasures

### 5.1 Research findings

According to the results in Table 4 Y apparel enterprises in 2013, 2015, 2016, 2017, 2019, 2021 the comprehensive technical efficiency of enterprises did not reach 1, indicating that these six years Y apparel enterprises did not achieve optimal efficiency, there may be different degrees of input redundancy and output shortage. Y apparel enterprises in 2013, 2015, 2016, 2019, 2021 the Technical efficiency did not reach 1, indicating that Y apparel enterprises did not maximize output in these five years. Y apparel enterprises' scale efficiency did not reach 1 in 2013, 2015, 2016, 2017, 2019 and 2021, indicating that the scale of enterprise development was not quite appropriate and did not reach the optimal state; and the decreasing scale efficiency of Y apparel enterprises in 2014-2017 means that Y apparel enterprises may have too large a scale of services and the risk of over-expansion of scale. The payoffs of scale are shown in Table 5, based on the input-output data of Y apparel enterprises from 2012 to 2021. The payoff coefficient = 1, indicating that the enterprise production reaches the peak, output is proportional to the input and reaches the optimal production scale.

### 5.2 Recommended responses

In this paper, the evaluation index of logistics performance of Y garment enterprise based on "double carbon policy" was constructed after practical investigation, and the weights of each index were determined by expert scoring, and the relevant conclusions were analyzed by using DEAP software combined with input and output data of Y garment enterprise from 2012-2021. Garment enterprises have problems such as over-expansion of scale and redundancy of inputs, and the



enterprises have not reached the optimum efficiency. In view of the above research results, the following recommendations are made.

First, actively introduce high-tech equipment. To respond to the national "double carbon policy", Y garment enterprises should focus on energy saving and emission reduction in the production process, and introduce new technology equipment, which is conducive to improving enterprise output and eliminating waste of resources.

Second, improve the efficiency of enterprise logistics and distribution. This includes improving the timeliness, safety, and cargo loading rate (improving cargo loading rate can reduce carbon emissions to a certain extent) of enterprise logistics distribution, and maximising enterprise profitability by effectively developing enterprise logistics resources or entrusting enterprise logistics-related business to third-party logistics companies to realise the complementary advantages of enterprises.

Third, improve the quality of enterprise logistics services, to ensure the timeliness of orders shipped and the degree of market product feedback, strengthen the use of enterprise logistics technology, the implementation of enterprise logistics system integration, information management. Effectively enhance enterprise warehouse management, optimize the production functions of various departments, update the enterprise logistics operation process; make reasonable allocation of enterprise resources, introduce advanced technology, talents and management systems, strengthen logistics management and enhance the core competitiveness of enterprises.

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